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VEGETATION OF UNDRAINED DEPRESSIONS ON THE SACRAMENTO PLAINS

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(WITH ONE FIGURE)

The observations here recorded were made in 1917 from March to May inclusive, chiefly in the neighborhood of Sacramento, California. Study, however, was extended in all directions for distances of 20 miles or more, and even to Chico, 90 miles north, and to Stockton, 40 miles south.

Most of the area is exceedingly flat and low. The city of Sacramento itself is at an altitude of 30 ft. above sea-level. Except to the east, in the Sierra foothills, there is scarcely a rise of 100 ft. within 25 miles. Soils are largely sand, sandy loam, sandy clay, and clay loam. Any fine grained soil which retains water is popularly known as "adobe," the term not being confined to clay.

The numerous shallow depressions¹ of the Sacramento plains² have arisen from the leaching out of limestone masses. They are of various extent, some only a few square meters in area and others 100 m. or more across, with a depth of a few centimeters or decimeters. The soil is very fine grained and holds water for an astonishingly long time after rains, often for one or two weeks. During the rainy period of winter these low places may be constantly full of water. Even with the lessened rainfall of early spring there is likely to be standing water during much of the month of March. Besides these vernal pools there are many shallow "draws," or ravines, having a vegetation cover which bears a resemblance to that of the undrained depressions. As would be expected, however, they have many more species of plants because

¹ These depressions could hardly escape the notice of botanists. Mention of their flora is made in the preface (p. 5) of JEPSON'S "Flora of Middle Western California," ed. 2. 1911.

² The term "Sacramento plains" is well established in botanical and popular writings, but these are not "plains" in the usual botanical sense. The vegetation is rather that of a vernal meadow or vernal prairie. During the growing period of March, April, and May the soil moisture is sufficient for the support of true mesophytic species; witness the abundance of European weeds.

of the more favorable edaphic conditions. The present paper will describe only the undrained depressions.

Early in March a spring outburst of flowering annuals occurs on the Sacramento plains. A conspicuous flora develops, which continues, with various changes, during two or three months. This vernal meadow-grassland shows great masses of color, due to the flowers of *Calandrinia*, *Eschscholtzia*, *Platystemon*, *Trifolium*, *Orthocarpus*, *Nemophila*, *Erodium*, *Lupinus*, *Gilia*, *Brodiaea*, *Layia*, *Lotus*, *Collinsia*, etc. Toward the latter part of May these annuals and the various grasses have ripened their seed, and the landscape has become brown.

The low places in the plains show no fresh vegetation for two or three weeks after the spring outburst takes place in the ordinary grassland, for the ground is still wet and cold. At 2 dm. the soil temperature is 12–15° C., instead of 18–21° as in the vernal meadow.

The earliest plant of the depressions is the "meadow-foam," *Floerkea Douglasii* (Limnanthaceae). This is a succulent herb about 1 dm. tall, with a profusion of white or roseate flowers. It shows first as a fringe at the margin of low areas, extending around on a contour line and resembling foam on a windy shore (fig. 1). Later, as the soil becomes drier and warmer, the meadow-foam works inward, meeting the vegetation that now appears in the central part of the depression. By May 1, at Sacramento, the meadow-foam has ceased blooming and has well developed fruits. Not all depressions have the fringe of meadow-foam here described, but very many do.

Two rather definite areas may be distinguished in the depressions. There is a central portion which remains wet for a longer period, and a marginal area around it which merges into the surrounding ordinary grassland. The central and marginal areas have their own characteristic plants. A condensed statement later in this article indicates seasonal differences in the appearance of the two areas.

Central area

The central area is characterized as a rule by a growth of *Allocarya californica*, a low, white-flowered borage, or sometimes by other species of the genus. Often the *Allocarya* forms a close

stand, with no other plants present.³ The *Allocarya*, however, is sometimes scattered, and the chief mass of vegetation is "gold-fields" (*Baeria* or *Lasthenia*). Because of the almost constant occurrence of *Allocarya*, these plant communities might well be called "Allocarya depressions." The *Allocarya* continues in bloom until late in the growing season, even after the general spring aspect has passed. Many of the plants of this late period



FIG. 1.—A depression in early spring showing a wide circum-area of meadow-foam (*Floerkea Douglasii*); outskirts of Sacramento.

are markedly depauperate in vegetative parts, and also as to size of flowers; but even during the early part of the season depauperate individuals are scattered among the more robust plants.⁴

Gold-fields (*Baeria* and *Lasthenia*) sometimes replace almost completely the *Allocarya* of the central area. At a distance they

³ The writer is familiar with such growths of *Allocarya* at Tolland, Colorado, in the Rocky Mountains along lake and stream margins in fine grained soil. The Colorado species in these places is *Allocarya scopulorum*.

⁴ Many Californian species have depauperate or otherwise atypical individuals mixed with plants of typical form, or in some cases occurring in special habitats. It is often difficult to determine in a given case whether the differences are genetic or merely due to crowding or other environmental factors.

may be mistaken for some low-growing *Ranunculus*, because of the profusion of yellow flowers. These plants are found where there is some loose loamy soil above the close grained adobe, or where there is some drainage, as in a shallow draw. If the soil at the center of the depression is fine adobe, then the *Baeria*, if present, will form a ring outside the centrally placed *Allocarya*. Or, if water stands an unusually long time in the center, there may be a growth of *Damasonium californicum* (Alismaceae), bounded by a ring of *Allocarya*, and this in turn by a circum-area of *Baeria*.

Within the inner area of the depressions *Downingia*, a small Lobeliaceous plant, becomes conspicuous in late spring because of its great abundance. Even at a distance it may be recognized by its pale blue tint, for it sometimes fills nearly the entire central part after the flowers of *Allocarya* have disappeared. In some cases the *Downingia* develops as a wide circum-area, not quite reaching the center of the depression. Often associated with *Downingia*, and sometimes replacing it, is *Gilia leucocephala*, which when in large masses gives a whitish tinge to the vegetation complex.

“Coyote thistle” (*Eryngium Vaseyi*) is a prickly umbellifer with inconspicuous flowers which occurs in the central part of most of the depressions. Occasionally it forms a rather dense growth, but is more often rather loosely scattered. Hence, although it is the largest of the plants found at any time in the depressions, it has little influence upon the general appearance of the vegetation until late in the season, when it has grown tall and leafy, and when the showy annuals have completed their growth and dried up. The coyote thistle plants have a glaucous appearance that dominates the depressions, replacing the pale blue of *Downingia*, which followed the white of *Allocarya* or the yellow of gold-fields.

Among the less abundant plants of the inner area is the “freckled monkey” (*Mimulus angustatus* and *M. tricolor*). The plants are small, even minute, and top-heavy with large purple flowers spotted with yellow. When not prominent because of numbers the freckled monkey can nearly always be found rather late in April if search is made for it on the surface of the dried mud among the coyote thistles. Another small plant often abundant, and

practically always represented by at least a few specimens, is *Psilocarphus brevissimus*, a whitish-headed composite scarcely 1 cm. tall.

Marginal circum-area

The marginal zone is characterized in late spring by *Deschampsia danthonioides*. Sometimes this grass forms an almost pure stand after the disappearance of the meadow-foam, which, it will be remembered, marked the marginal zone in the first part of the season. As would be expected, the marginal zone is subject to invasion from within and from without, but it remains, as a rule, a very definite and distinct entity.

The inner boundary of the marginal circum-area is sometimes made by a thin line of *Achyryachaena mollis*, an inconspicuous composite that becomes noticeable in fruit by the spreading out of its silvery pappus. This same narrow line may be marked a little later in the season by a scattered ring of a kind of tarweed, *Hemizonia Fitchii*. Neither the *Achyryachaena* nor the tarweed, however, are essential elements in the circum-area; often they are entirely absent.

The ordinary drained areas of the Sacramento plains have a large proportion of introduced plants, especially grasses, bur clover, and species of *Erodium*. This is true of abandoned fields and of areas never under cultivation. The depressions, on the contrary, have an almost strictly native vegetation. If a patch of cultivated ground is left untouched, the depressions soon return to their original condition, unless the field has been thoroughly manured and cultivated. This recrudescence of the original vegetation, of course, is readily possible where most of the species are annuals. A definite case of return of native flora was noted in North Sacramento. An abandoned field had grown up to European grasses and weeds, but a low place in it, which plainly showed the marks of previous cultivation, was now like any of the primitive untouched adobe depressions. On May 15, 1917, the vegetation of the central area, about 10 m. across, was chiefly *Allocarya* and *Eryngium*, with a small amount of *Mimulus*, *Downingia*, *Gilia leucocephala*, and *Deschampsia danthonioides*. Outside this central part was a wide circum-area dominated at this time by *Deschampsia*,

with dried plants of meadow-foam, showing that the early spring aspect also had been of the usual type. Subordinate elements of the marginal ring were chiefly introduced weeds, *Silene*, *Lepidium*, *Hypochaeris*, *Rumex*.

The changing appearance of the depressions following the advance of the season may be shown best by a tabular statement.

PREVERNAL ASPECT

CENTRAL AREA.—Scattered plants of *Eryngium* left over from the previous season, but most of the ground bare.

MARGINAL ZONE.—*Floerkea* forming a more or less dense ring extending out to the ordinary grassland. The ring is often invaded toward the outside by species of the adjacent area, such as various native clovers, *Orthocarpus*, and European weeds.

MID-VERNAL ASPECT

CENTRAL AREA.—*Eryngium* actively growing but not yet of full size. *Allocarya* develops and blooms at the true beginning of spring; often forms a close community. *Baeria* and *Lasthenia*, if present at all, are likely to appear early. *Mimulus* sparingly present. Young plants of *Alopecurus* becoming abundant.

MARGINAL ZONE.—*Deschampsia* now showing definitely as a close growth of young plants. Native clovers in flower and fruit. Young plants of *Achyryachaena*. Introduced weeds.

LATE VERNAL ASPECT

CENTRAL AREA.—*Eryngium* now taller and more conspicuous than before. *Allocarya* continued from the previous aspect, but the plants now in bloom are depauperate. *Baeria* and *Lasthenia* in fruit or now drying up, with a few belated ones still blooming. *Alopecurus*, *Mimulus*, *Gilia leucocephala*, *Psilocarphus*, and *Downingia* in flower and fruit. In many places the last named very abundant and giving character to the entire depression.

MARGINAL ZONE.—*Deschampsia* in flower and fruit. *Downingia* scattered through the inner part of the marginal zone. Native clovers and *Orthocarpus* in fruit. *Achyryachaena mollis* in fruit.

At the outer boundary of the zone various introduced weeds now in flower and fruit.

Systematic list

The species of the depressions are recorded in the following list. Reference letters have the following significance: *C*, characteristic; *F*, frequent; *O*, occasional.⁵

- Alismaceae
- Damasonium californicum (F. and M.) Greene, *O*
- Poaceae
- Alopecurus californicus Vasey, *F*
- Alopecurus geniculatus Linn., *F*
- Deschampsia danthonioides Munro, *C*
- Phalaris Lemmoni Vasey, *O*
- Cyperaceae
- Eleocharis acicularis R. Br., *O*
- Juncaceae
- Juncus tenuis Willd., *O*
- Limnanthaceae
- Floerkea Douglasii Baill., *C*
- Lythraceae
- Lythrum hyssopifolium Linn., *O*
- Onagraceae
- Boisduvallia stricta (Gray) Greene, *O*
- Apiaceae
- Eryngium Vaseyi C. and R., *C*
- Polemoniaceae
- Gilia intertexta Steud., *O*
- Gilia leucocephala Benth., *C*
- Boraginaceae
- Allocarya californica (F. and M.) Greene, *C*
- Allocarya stipata Greene, *O*
- Allocarya trachycarpa (Gray) Greene, *F*
- Lamiaceae
- Pogogyne ziziphoroides Benth., *O*
- Scrophulariaceae
- Mimulus angustatus Gray, *F*
- Mimulus tricolor Hartw., *C*

⁵ The writer is under obligation to Professor HARVEY M. HALL for the privileges of the University of California Herbarium, and to both Professor HALL and Miss WALKER in naming for him a considerable collection of Californian plants.

Lobeliaceae
Downingia pulchella (Lindl.) Torr., C
Carduaceae
Achyrrachaena mollis Shauer, F
Baeria chrysostoma gracilis (DC.) Hall, C
Baeria Fremontii Gray, C
Baeria platycarpa Gray, F
Blennosperma californicum (DC.) T. and G., O
Hemizonia Fitchii Gray, O
Lasthenia glabrata DC., O
Psilocarphus brevissimus Nutt., C
Cichoriaceae
Hypochaeris glabra Linn. (introduced), F

Summary

The numerous depressions of the Sacramento plains have a very fine grained soil, where water stands during the period of winter rain and even well into early spring. The vegetation is very different from that of the usual grassland of the region, being composed of very few species, with practically no introduced weeds. The depressions usually show a central area and a marginal zone, the former characterized by a dense growth of *Allocarya* or *Baeria*, and the latter by *Floerkea Douglasii* and *Deschampsia danthonioides*. Subordinate species of both areas are noted and the seasonal changes indicated. A systematic list is given of 29 species, 10 of which are marked as characteristic, 8 as frequent, and 11 as merely occasional.

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